Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of	)	
	)	
Unlicensed Use of the 6 GHz Band	)	ET Docket No. 18-295
	)	
Expanding Flexible Use in Mid-Band Spectrum Between 3.7 and 24 GHz	)	GN Docket No. 17-183
	)	
	)	

COMMENTS OF WI-FI ALLIANCE

Alex Roytblat
Senior Director of Regulatory Affairs

WI-FI ALLIANCE
10900-B Stonelake Blvd.
Suite 126
Austin, TX 78759
(512) 498-9434
aroytblat@wi-fi.org

February 15, 2019

TABLE OF CONTENTS

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of	)	
	)	
Unlicensed Use of the 6 GHz Band	)	ET Docket No. 18-295
	)	
Expanding Flexible Use in Mid-Band Spectrum Between 3.7 and 24 GHz	)	GN Docket No. 17-183
	)	
	)	

COMMENTS OF WI-FI ALLIANCE

Wi-Fi Alliance submits these comments in response to the Notice of Proposed Rulemaking in the above-referenced proceedings in which the Commission seeks input on unlicensed use of the 5.925-7.125 GHz ("6 GHz") band.[1/] Wi-Fi Alliance applauds the Commission for initiating this proceeding, which is premised on two incontrovertible facts. First, unlicensed spectrum and the services it supports – Wi-Fi in particular – are essential drivers of our Nation's economy and a key component of its communications infrastructure. And second, there is simply insufficient spectrum capacity to support the growing demand for Wi-Fi. Wi-Fi Alliance urges the Commission to move quickly to adopt rules allowing unlicensed access to the 6 GHz band, including authorizing low-power, indoor-only ("LPI") devices across the entire band and permitting standard-power operations in designated segments of the band. Wi-Fi Alliance offers modifications to the Commission's proposal that, if adopted, will ensure protection of incumbent operations, while providing critically needed additional spectrum access for unlicensed uses like Wi-Fi.

1/ *In the Matter of Unlicensed Use of the 6 GHz Band*, ET Docket No. 18-295, FCC 18-147 (rel. Oct. 24, 2018) ("*NPRM*").

I. BACKGROUND AND SUMMARY

Wi-Fi Alliance®[2/] is a global, non-profit industry association of over 800 leading companies from dozens of countries devoted to seamless interoperability. With technology development, market building, and regulatory programs, Wi-Fi Alliance is the organization that enables widespread adoption of Wi-Fi® worldwide by certifying thousands of Wi-Fi products each year. It is also an active participant before the Commission, other U.S. fora, and in international proceedings to, among other things, promote governmental actions that facilitate Wi-Fi connectivity and maximize unlicensed spectrum availability.

A. Wi-Fi is an Integral Component of Telecommunications Infrastructure and Economic Growth

With over 800 million household access point ("AP") installations and 340 million Wi-Fi hotspots around the world, Wi-Fi is the primary on-ramp to the Internet – providing access in homes and businesses and on the go, with hotspots on planes, trains, and in cars, as well as in coffee shops, restaurants, and hotels.[3/] As one economist (and former Commissioner) recently wrote, "[w]hen a wireless user—effectively, everyone—goes for the first time to an office,

---

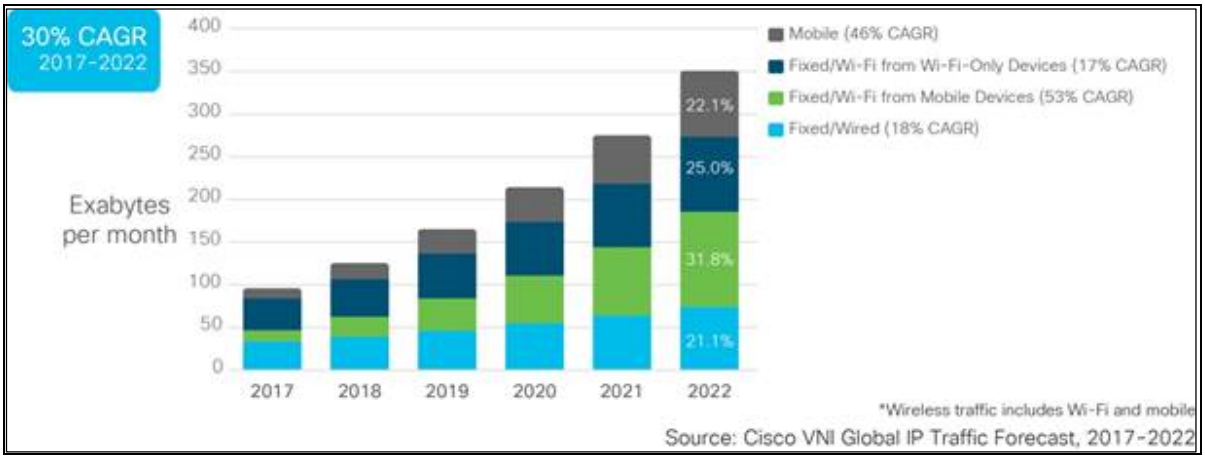
[2/] Wi-Fi®, the Wi-Fi logo, the Wi-Fi CERTIFIED logo, Wi-Fi Protected Access® (WPA), WiGig®, the Wi-Fi Protected Setup logo, Wi-Fi Direct®, Wi-Fi Alliance®, WMM®, Miracast®, Wi-Fi CERTIFIED Passpoint® , and Passpoint® are registered trademarks of Wi-Fi Alliance. Wi-Fi CERTIFIED™, Wi-Fi Protected Setup™, Wi-Fi Multimedia™, WPA2™, WPA3™, Wi-Fi CERTIFIED Miracast™, Wi-Fi ZONE™, the Wi-Fi ZONE logo, Wi-Fi Aware™, Wi-Fi CERTIFIED HaLow™, Wi-Fi HaLow™, Wi-Fi CERTIFIED WiGig™, Wi-Fi CERTIFIED Vantage™, Wi-Fi Vantage™, Wi-Fi CERTIFIED TimeSync™, Wi-Fi TimeSync™, Wi-Fi CERTIFIED Location™, Wi-Fi Location™, Wi-Fi CERTIFIED Home Design™, Wi-Fi Home Design™, Wi-Fi CERTIFIED Agile Multiband™, Wi-Fi Agile Multiband™, Wi-Fi CERTIFIED Optimized Connectivity™, Wi-Fi Optimized Connectivity™, Wi-Fi CERTIFIED EasyMesh™, Wi-Fi EasyMesh™, Wi-Fi CERTIFIED Enhanced Open™, Wi-Fi Enhanced Open™, Wi-Fi CERTIFIED Easy Connect™, Wi-Fi Easy Connect™, Wi-Fi CERTIFIED 6™ and the Wi-Fi Alliance logo are trademarks of Wi-Fi Alliance.

[3/] Telecom Advisory Servs., THE ECONOMIC VALUE OF WI-FI: A GLOBAL VIEW (2018 AND 2023), at 10 (rel. Oct. 2018) https://www.wi-fi.org/value-of-wi-fi ("*Economic Value of Wi-Fi*"). The report noted that Wi-Fi is a "key enabler" of forthcoming 5G mobile networks, and incorporated many of those benefits into its analysis.

home, school, restaurant, or any other public place in America, one of the first questions the user asks is: 'What is the Wi-Fi password?'"[4/]

The importance of Wi-Fi to consumers and businesses will continue to grow with increased demand for ubiquitous connectivity. As shown below, CISCO's recently released VNI analyses indicate that Wi-Fi carries more than 50% of the total Internet traffic in the U.S., and that number is expected to increase dramatically in the coming years.[5/]

Figure 1: Growth of Total U.S. Internet Traffic by Type



More than three quarters of American households rely on Wi-Fi as their primary connection technology.[6/]

[4/] Harold Furchtgott-Roth, *Wi-Fi Helps Define the Relevant Market for Wireless Services*, (Sept. 2018), https://newtmobile.com/content/uploads/2018/12/Furchtgott-Roth-WiFi-Helps-Define-the-Relevant-Market-for-Wireless-Ser....pdf.

[5/] CISCO, VNI Complete Forecast Highlights Tool, North America, United States, Wired Wi-Fi and Mobile Growth (2018), http://www.cisco.com/c/m/en_us/solutions/service-provider/vni-forecast-highlights.html (select "United States" from the "North America" drop-down menu, select "2022 Forecast Highlights" and expand "Wired Wi-Fi and Mobile Growth.") (finding that "fixed/Wi-Fi was 50.4% of total Internet traffic in 2017, and will be 56.6% by 2022." In contrast, pure mobile traffic carried only 4.3% of the total Internet traffic in 2017, and is expected to rise to 6.6% by 2022).

[6/] Doug Brake, *Keeping Up with Spectrum Policy: Mid-Band Opportunities*, INFORMATION TECHNOLOGY AND INNOVATION FOUNDATION, 7 (Nov. 2018) ("*ITIF White Paper*") http://www2.itif.org/2018-spectrum-policy-mid-band.pdf?_ga=2.81837206.1055728607.1546453832-373585763.1546453832.

Cellular traffic offload also continues to be a significant and growing Wi-Fi demand driver.[7/] The amount of traffic offloaded to Wi-Fi from cellular networks has increased with each generation of cellular technology (*i.e.*, 2G, 3G, and 4G). This trend is expected to continue at an even greater rate with Fifth Generation wireless ("5G") data-intensive applications spurring the demand for Wi-Fi capacity. Wi-Fi will be essential to extending carrier 5G networks' coverage and enabling ubiquitous, low-latency broadband connections.[8/] Wi-Fi is a "key enabler" of carrier 5G networks,[9/] because those 5G networks cannot, on their own, fulfill the promise of ubiquitous broadband coverage.[10/] Not surprisingly, Chairman Pai correctly identified unlicensed Wi-Fi as part of the comprehensive strategy to Facilitate America's Superiority in 5G Technology ("5G FAST") Plan.[11/]

7/ *See, e.g.*, Mike Dano, *Cellular and Wi-Fi Use – by operator and data plan type*, Fierce WIRELESS (Mar. 21, 2018, 8:13 AM) https://www.fiercewireless.com/wireless/cellular-and-wi-fi-use-by-operator-and-data-plan-type-for-verizon-at-t-t-mobile-and-1 (showing that over 75% of overall smartphone data travels over Wi-Fi, rather than commercial wireless, networks).

8/ *See, e.g.*, Brian Santo, *Wi-Fi vs. 5G? Nope, it's both*, EDN NETWORK, (Dec. 5, 2017) https://www.edn.com/electronics-blogs/5g-waves/4459120/Wi-Fi-versus-5G--Nope--it-s-both.

9/ *See generally Economic Value of Wi-Fi*.

10/ Like 5G, Wi-Fi works across spectrum bands, taking advantage of different standards and propagation characteristics to provide the right performance for the required use case. Despite the increased capacity of wireless carriers, the demands that a 5G economy will place on commercial wireless networks will make offloading of traffic onto Wi-Fi even more crucial in the future, especially as Wi-Fi 6 and WiGig promise speeds and performance that rivals or exceeds those of 5G networks. *See, e.g.*, Jacob Kastrenaks, *Qualcomm's new Wi-Fi Chips are meant to rival 5G speeds*, THE VERGE (Oct. 16, 2018), https://www.theverge.com/circuitbreaker/2018/10/16/17980124/80211ay-wigig-qualcomm-wifi-10-gigabit-speeds.

11/ FCC, THE FCC'S 5G FAST PLAN (rel. Sept. 28, 2018) ("*5G FAST Plan*").

Wi-Fi also provides ways for devices to connect to one another, such as for virtual reality, file transfer, and local video streaming.[12/] That is why Wi-Fi is, and will continue to be, an important part of the Internet of Things ("IoT") architecture.[13/]

Not only is Wi-Fi an increasingly vital component of the Nation's telecommunications infrastructure, it is also a critical driver of economic growth. A recently produced analysis of the economic value of Wi-Fi concluded that the annual Wi-Fi contribution to the U.S. economy is almost $500 billion today, and will nearly double by 2023.[14/] The report found that Wi-Fi is an "enabling resource" that extends connectivity to underserved areas, allows other innovative products and services to develop and thrive (including portable devices that require Internet access but lack a cellular connection), expands access to communications services and increases the value of those offerings (such as by spreading a wireline connection throughout the home and through off-loading to reduce the strain on cellular networks), and enhances the effectiveness of existing product and service offerings (such as "smart home" devices).[15/]

B. Spectrum Shortfall Threatens Wi-Fi Performance and Viability

As with any wireless technology, Wi-Fi's functionality depends on adequate access to spectrum capacity. Wi-Fi's performance, capabilities, and its role in the Nation's telecommunications infrastructure and economy are threatened by the lack of sufficient spectrum access. To assess this threat, Wi-Fi Alliance commissioned a Spectrum Needs Study that

---

12/ *See* Wi-Fi Alliance, *Discover Wi-Fi: Wi-Fi Certified Wi-Gig*, https://www.wi-fi.org/discover-wi-fi/wi-fi-certified-wigig.

13/ Wi-Fi Alliance is developing a standard for IoT operations in sub-1 GHz spectrum that will allow for low-power, long-distance operations for machine-to-machine connections. *See* Wi-Fi Alliance, *Discover Wi-Fi: HaLow*, http://www.wi-fi.org/discover-wi-fi/wi-fi-halow.

14/ *See generally Economic Value of Wi-Fi*.

15/ *Id.*

analyzed current and future Wi-Fi spectrum requirements.[16/] Based on projected growth in demand for Wi-Fi, by 2025, up to 1500 megahertz of additional mid-band spectrum may be needed to sustain the Wi-Fi ecosystem.[17/]

Wi-Fi Alliance is not alone in recognizing that additional spectrum will be needed to support Wi-Fi. Congress has acknowledged this requirement, both in the form of legislative directives to the Commission and other Federal agencies,[18/] and in letters from individual members to the Commission.[19/] Even before the adoption of the *NPRM*, members of the Commission also recognized this need.[20/] Indeed, Chairman Pai observed this in the 5G FAST

16/ Wi-Fi Alliance, *Spectrum Needs Study* (Feb. 2017), https://www.wi-fi.org/downloads-registered-guest/Wi-Fi%2BSpectrum%2BNeeds%2BStudy0.pdf/33364 ("Spectrum Needs Study").

17/ *Id.* at 1. The Spectrum Needs Study also evaluated different spectrum requirement scenarios, depending in part on whether current spectrum with dynamic frequency selection ("DFS") limitations can be made more accessible. The Spectrum Needs Study found that if there is greater use of DFS-limited spectrum, spectrum needs for Wi-Fi may be reduced to 600 megahertz. *Id.* at 25.

18/ *See Consolidated Appropriations Act 2018*, Pub. L. No. 115-141, div. P, tit. VI, § 603 (requiring the Commission to identify a minimum of 100 megahertz of spectrum below 8 GHz for unlicensed operation by 2022); § 611 (requiring the Commission to evaluate unlicensed operations in guard bands); § 617 (making the promotion of unlicensed spectrum the official policy of the United States and charging the Commission with making unlicensed spectrum a priority); and § 618 (requiring the Commission to work with NTIA to draft a "National Plan for Unlicensed Spectrum" by September 23, 2020 which will lead to increased unlicensed spectrum access). *See also Middle Class Tax Relief Act of 2012*, Pub. L. No. 112-96, §§ 6406 and 6407 (requiring unlicensed operations in the 5 GHz Band and guard bands).

19/ *See* Letter from Ben Guthrie and Doris Matsui, Co-Chairs, Congressional Spectrum Caucus, to Ajit Pai, Chairman, FCC, July 11, 2018; and Letter from John Thune, Chairman, Senate Committee on Commerce, Science and Transportation to Ajit Pai, Chairman, FCC, June 29, 2018. The recent creation of a Wi-Fi Caucus signals growing Congressional interest in Wi-Fi. *See* Press, Release, Reps. McNerney and Latta Launch Bipartisan Wi-Fi Caucus (Oct. 4, 2018) https://mcnerney.house.gov/media-center/press-releases/reps-mcnerney-and-latta-launch-bipartisan-wi-fi-caucus.

20/ *See e.g. In the Matter of Revision of Part 15 of the Commission's Rules to Permit Unlicensed National Infrastructure (U-NII) Devices in the 5 GHz Band*, 28 FCC Rcd 1769 at ¶¶ 2, 15 (noting that increased unlicensed spectrum would "foster the development of new and innovative unlicensed devices, and increase wireless broadband access and investment" and that U-NII devices play an increasingly important role in meeting the demand for wireless broadband.). *See also* Jessica Rosenworcel, Commissioner, FCC, Remarks at Silicon Flatirons Conference (Sept. 6, 2018) ("Right now, there are over 9 billion Wi-Fi enabled devices. Before the end of the decade, we will see as many as 50 billion new devices connecting to our networks through the internet of things [spectrum above the 5 GHz band] is the ideal place to explore Wi-Fi expansion because it's adjacent to an existing unlicensed band."); Letter from Ajit Pai, Chairman, Federal Communications Commission, to John Thune, Chairman, Senate Committee

Plan, which included "creating new opportunities for the next generation of Wi-Fi in the 6 GHz" band.[21/] Similar recognition of the need for more mid-band spectrum for Wi-Fi has come from across the communications industry.[22/]

Yet, despite the chorus of support for additional spectrum capacity in light of growing demand for Wi-Fi, little progress has been made.[23/] The lack of additional spectrum access to the 5150-5925 MHz ("5 GHz") band for Wi-Fi is particularly frustrating because for years industry has waited for expanded access to the band to implement the next generation of Wi-Fi.

---

on Commerce, Science, and Transportation, Aug.10, 2018 ("That's why I have announced that the Commission will be moving forward with a rulemaking to consider opening up the 6 GHz band to unlicensed use this fall."); Michael O'Rielly, *This is World Wi-Fi Day, Let's Celebrate the Progress We've Made*, THE HILL, June 19, 2017 ("To say that Wi-Fi is a critical component of Internet access in today's always-connected society doesn't do it justice…But more needs to be done to promote future opportunities. This includes making more spectrum bands available for unlicensed use to allow super-wide Wi-Fi channels.").

21/ *See generally 5G FAST Plan.*

22/ The Information Technology and Innovation Foundation recently noted that spectrum shortages risk limiting future growth of Wi-Fi, and expressed its hope that the Commission would "act with speed to open up the 6 GHz band for unlicensed operations." *ITIF White Paper* at 8. At Wi-Fi Forward's recent Wi-Fi Summit, representatives from across the communications industry came together to discuss the importance of Wi-Fi to the Internet ecosystem and the risk that lack of spectrum is suppressing economic growth. *See* Wi-Fi Forward, *Bipartisanship is Back at the Second Annual Wi-Fi Summit*, Dec. 3, 2018, http://wififorward.org/2018/12/03/bipartisanship-is-back-at-the-second-annual-wi-fi-summit/. NCTA– The Internet and Television Association has noted that "more spectrum [means] better Wi-Fi" and has called on the Commission to open up more mid-band spectrum to prevent coming spectrum shortages that will limit future growth and innovation. NCTA – The Internet & Television Association, *More Spectrum, Better Wi-Fi*, July 25, 2018, https://www.ncta.com/whats-new/more-spectrum-better-wi-fi. *See also Comments of Broadcom Ltd.*, GN Docket No. 17-183 at 25 (filed Oct. 2, 2017) (calling the 6 GHz band "critical to addressing the unlicensed spectrum crunch."); *Comments of Charter Communications, Inc.*, GN Docket No. 17-183 (filed Oct. 2, 2017) and *Comments of NCTA – The Internet and Television Association*, GN Docket No. 17-183 (filed Oct. 2, 2017) (both discussing the central role of Wi-Fi in their networks and the importance of the 6 GHz band for future operations); and *Reply Comments of the Open Technology Institute and Public Knowledge*, GN Docket No. 17-183 at 25 (filed Nov. 15, 2017) and *Comments of All Points et al.*, GN Docket No. 17-183 at 2 (filed Oct. 2, 2017) (both noting the widespread consensus on the need for additional spectrum, as much as 500 megahertz within the next decade). Generally, the record in the Notice of Inquiry exploring potential new uses of mid-band spectrum that preceded the NPRM similarly demonstrates support for the Commission making unlicensed spectrum available. *Expanding Flexible Use in Mid-Band Spectrum Between 3.7 and 24 GHz*, Notice of Inquiry, GN Docket No. 17-183 (rel. Oct. 3, 2017) ("NOI").

23/ *See Comments of Wi-Fi Alliance*, GN Docket No. 17-183 at 25 (filed Oct. 2, 2017).

Unfortunately, the absence of progress has made it increasingly apparent that mid-band spectrum access and bandwidth needed to support next generation Wi-Fi wider channels will *not* be accommodated in the 5 GHz band.

For instance, the National Telecommunications and Information Administration, after years of consideration, has made it clear that unlicensed operations in the 5.35-5.47 GHz (U-NII-2B) band will not be permitted, significantly disrupting plans to accommodate growing demand for Wi-Fi in that spectrum.[24/] Similarly, despite continued attention from inside and outside the Commission, the future of the U-NII-4 band remains uncertain, with the testing of potential sharing solutions between proposed U-NII-4 and Dedicated Short Range Communications operations only recently reaching the end of Phase I.[25/] While Commission action in other frequency ranges, including the 600 MHz band White Spaces[26/] and millimeter wave bands,[27/] may address some unlicensed spectrum capacity requirements, the urgent need for unlicensed mid-band spectrum has not been resolved.

The 6 GHz band is uniquely suited to facilitate the continued success and future growth of Wi-Fi. The radiofrequency propagation characteristics of the 6 GHz band are similar to the adjacent 5 GHz band, which, despite limitations, supports current Wi-Fi deployments. And the

---

24/ *See NOI* at ¶ 28.

25/ *See Office of Engineering and Technology Requests Comment on Phase I Testing of Prototype U-NII-4 Device*s, Public Notice, ET Docket No. 13-49 (rel. Oct. 29, 2018); *Statement of Commissioner Michael O'Rielly on 5.9 GHz Phase I Testing Data* (rel. Oct. 29, 2018); *Statement of Commissioner Jessica Rosenworcel on Phase 1 Test Report of Prototype U-NII-4 Devices*, rel. Oct. 29, 2018; and Letter from Rick Chessen, NCTA, to Marlene H. Dortch, Secretary, FCC, ET Docket No. 13-49 (Oct. 16, 2018). While Wi-Fi Alliance has urged, and continues to urge, the Commission to make the U-NII-4 band available for unlicensed operations, its future remains uncertain.

26/ *See In the Matter of Amendment of Part 15 of the Commission's Rules for Unlicensed Operations in the Television Bands et al.*, Report and Order, 30 FCC Rcd 9551 (2015).

27/ *See In the Matter of Use of Spectrum Bands Above 24 GHz For Mobile Radio Services*, Report and Order and Further Notice of Proposed Rulemaking, 31 FCC Rcd 8014 (2016).

proximity of the 6 GHz band to the 5 GHz band means that existing devices can be readily redesigned. Most importantly, the 6 GHz band offers contiguous spectrum blocks to accommodate 160 megahertz channels, which are required for high-bandwidth applications such as high-definition video streaming and virtual reality. The next generation of Wi-Fi (based on IEEE 802.11ax), also known as "Wi-Fi 6,"[28/] is designed to support these high-data throughput applications.[29/] In short, the future of Wi-Fi technology and its ability to continue to deliver a desirable user experience, connectivity, economic value, and many other benefits depends on access to the *entire* 6 GHz band.

II. COMMENTS

Wi-Fi Alliance enthusiastically supports the Commission's proposal to extend unlicensed operations to the entire 6 GHz band, [30/] subject to the modifications discussed below. It agrees with the proposal to divide the 6 GHz band into the U-NII-5 (5.925-6.425 GHz), U-NII-6 (6.425-6.525 GHz), U-NII-7 (6.525-6.875 GHz), and U-NII-8 (6.875-7.125 GHz) sub-bands,[31/] based on the characteristics of incumbent services. The mechanism for regulating unlicensed use in the 6 GHz band should be based, as the Commission suggests, on a "two-class approach," which differentiates between LPI AP and standard-power AP devices.[32/]

Based on its in-depth analysis of the Commission's proposal, Wi-Fi Alliance urges the Commission to consider the following adjustments and clarifications:

28/ *See* Wi-Fi Alliance, *Discover Wi-Fi: Wi-Fi 6*, https://www.wi-fi.org/discover-wi-fi/wi-fi-6.

29/ *Spectrum Needs Study* at 18. *See also* National Instruments, Introduction to 802.11ax High-Efficiency Wireless (July 24, 2017), http://www.ni.com/white-paper/53150/en/.

30/ *See generally NPRM*.

31/ *Id.* at ¶ 21.

32/ *Id.* at ¶ 21.

- Allow LPI operations across the *entire* 6 GHz band, including the U-NII-5 and U-NII-7 bands, without an unnecessary automatic frequency coordination ("AFC") requirement for those bands.
- Allow standard-power AP operations in the U-NII-8 band using AFC technology to avoid transmissions in areas where TV pickup operations are licensed.
- Allow client devices that operate under the control of an AP to operate at the same power level as the AP (whether standard-power or LPI).
- Based on the precedent and operational experience established in the adjacent 5 GHz band, allow operation of fixed point-to-point operations with higher-gain antennas.
- Recognizing the growing necessity of portability to modern wireless communications use cases, allow mobile and transportable U-NII operations based on regulatory conditions comparable to LPI U-NII devices (*i.e.*, applying very low power transmit power levels) or by using AFC technology.

A. Low Power Indoor-Only Operations Across the 6 GHz Band

Wi-Fi Alliance supports the Commission's proposal to allow the use of LPI devices in the U-NII-6 and U-NII-8 bands without AFC.[33/] It, however, urges the Commission to permit deployment of LPI devices in the U-NII-5 and U-NII-7 bands without AFC as well, under a harmonized regulatory regime across the entire 6 GHz band. As explained below, AFC is not necessary for LPI operations in *any* segment of the 6 GHz band.

33/ *Id.* at ¶ 21 and proposed new 47 C.F.R. §15.407(d)(3). The proposed new 47 C.F.R. §15.407(k)(1) would also need to be amended to specify that only standard-power devices would be subject to the AFC requirement.

LPI devices will protect incumbent operations in these sub-bands in the same way that they will protect incumbents in the U-NII-6 and U-NII-8 bands – protection that the Commission recognized is achievable. There are no technical reasons to limit LPI operations to only the U-NII-6 and U-NII-8 bands. To the contrary, there are important reasons to make the entire 6 GHz band available for LPI without AFC. Most importantly, a regulatory scheme that restricts LPI operations to less than a third of the available spectrum, in disjointed segments, will fail to address the urgent need for contiguous spectrum capacity to support wider bandwidth channels.

1. Protection of Fixed Service Operations

LPI U-NII transmissions (less than 250 mW conducted power) will not cause harmful interference to incumbent fixed service ("FS") operations. As Wi-Fi Alliance has previously detailed, LPI transmissions will be attenuated by building entry losses, clutter loss, and polarization mismatch losses, all of which will reduce the signal power to below the potential harmful interference threshold.[34/] Antenna array losses will also reduce the potential for harmful interference.

a. Antenna Array Losses

Current and proposed technology for unlicensed devices today has, and will continue to have, multiple antennas for multiple spatial streams. Multiple spatial antenna arrays see losses from the difference in alignment of the various antennas. Because the antennas are not aligned in phase, some of the energy will be lost in each direction, reducing interference potential.

[34/] *See* Letter from Alex Roytblat, Senior Director, Regulatory Affairs, Wi-Fi Alliance, to Marlene H. Dortch, Secretary, FCC, GN Docket No. 17-183 (filed Sept. 18, 2018).

b. Building Entry Loss

The vast majority of the energy from an LPI U-NII device's transmission will be contained indoors and will not reach FS receivers. The limited amount of the energy from an LPI device's transmission that may propagate outside of a building structure would be further attenuated over the separation distance between the LPI device and a fixed service receiver.

While FS receiver tower heights average approximately 40 meters,[35/] most residential and general commercial LPI installations will be placed near ground level, well outside a FS link's main beam. In the unlikely scenario of a microwave link's main beam passing through a building, it will almost certainly be a high-rise building, one constructed of materials (*e.g.*, steel, concrete) that would further impede the LPI signal's propagation and, thereby, diminish the possibility of harmful interference to FS operations. As the Commission correctly noted, the building entry loss ("BEL") value of high-rise buildings (*i.e.*, 40 meters above ground level – about 12 stories) is significantly higher than average: 18 dB for "traditional" construction in contrast to 30 dB for these "thermally efficient" buildings.[36/] Building codes that are widely applied to taller, modern buildings mandate energy efficiency – which in turn provides for higher BEL values resulting in greater signal attenuation and lower risk of interference.[37/]

In addition to the ITU model cited by the Commission, a comprehensive study produced by Ofcom[38/] confirms BEL values for a variety of building materials. In particular, according to the Ofcom study, the losses from foil-backed insulation and metalized double glazed windows,

---

35/ *See WFA August Ex Parte* at Appendix, citing to ULS data.

36/ *NPRM* at ¶ 70.

37/ *Id.* at ¶ 70.

38/ Ofcom, *Building Materials and Propagation Final Report* (Sept. 14, 2014), https://www.ofcom.org.uk/__data/assets/pdf_file/0016/84022/building_materials_and_propagation.pdf ("*Ofcom Report*").

such as those found in modern office buildings, would exceed 30 dB.[39/] Despite claims to the contrary,[40/] studies show that low e-glass, double-glazed, energy saving windows that are primarily used in taller, modern buildings shield the signal at 6 GHz an average of 30 dB.

c. Clutter Loss

Further signal attenuation will result from clutter loss, meaning even less of the LPI's emissions will potentially interfere with an FS link. Clutter loss refers to the absorption of a transmission by objects that are on the surface of the earth, but are not actually terrain. This can include furnishings, interior building walls, or vegetation (in particular, trees). BEL loss from inside the building will absorb a substantial portion of the energy from an LPI device's transmission while outdoors, trees and other obstacles (*e.g.*, structures) will diminish the transmission's energy even further, reducing its interference potential.[41/] As the Commission correctly noted in the *NPRM*, this combination of building attenuation and clutter losses will protect incumbent licensed services from harmful interference from LPI devices because the vast majority of these devices' energy will be absorbed before reaching locations where interference is possible.[42/]

d. Polarization Mismatch Loss

Further reduction of the interference potential from an LPI device's transmissions will be provided by polarization mismatch loss.[43/] Polarization mismatch loss occurs when the receiving

---

39/ *Id.* at Section 4. While the *Ofcom Report* covers frequencies up to 5 GHz, the BEL factor would increase for frequencies in the 6-7 GHz range (*see Ofcom Report*, Figure 4.4*)*.

40/ Letter from Cheng-Yi Liu, Counsel to the Fixed Wireless Communications Coalition, to Marlene H. Dortch, Secretary, FCC, GN Docket No. 17-183 (filed Oct. 15, 2018).

41/ *See* ITU Recommendation P.452-16 at Section 4.5 ("Additional Clutter Losses") (July 2015).

42/ *NPRM* at ¶¶ 61, 63.

43/ Wi-Fi Alliance observes that polarization mismatch is not specific to LPI and would help prevent interference from outdoor devices as well.

antenna does not use the same polarization as the incoming transmission. When this mismatch occurs for a desirable transmission, the resulting loss reduces link efficiency, but when it occurs for an undesirable transmission, it is beneficial because it reduces the receptivity of the interfering signal. The level of polarization mismatch varies depending on antennas' configuration, orientation, tilt, and other factors. Consequently, the polarization mismatch loss factor can be modeled by $\text{Cos}^2\ \theta$ (where θ is the misalignment angle, randomly distributed between 0 and 180 degrees) resulting in a 50% probability that the interfering signal attenuation due to polarization mismatch loss will be greater than 3 dB.[44/]

e. Multipath Fading Effects

The interference potential of LPI devices is reduced even further when FS links' excess margin to overcome effects of the atmospheric (multipath) fading is considered. The Commission correctly noted the seasonal, geographic, and weather-based nature of multipath fading, and recognized that the excess nature of this margin should be factored into interference concerns.[45/] As the Commission noted, citing to information derived directly from incumbents themselves,[46/] 6 GHz fixed microwave systems are designed with fade margins of 25-40 dB to overcome these fluctuations in the atmospheric conditions.[47/] As the Commission observed, in these frequencies, multipath fading occurs primarily at night or in the early morning hours,[48/] exactly when the use of U-NII devices will be at its lowest, particularly in high-rise office buildings.

44/ Ranga Rodrigo, FUNDAMENTAL PARAMETERS OF ANTENNAS, Lecture Notes, http://www.ent.mrt.ac.lk/~ranga/courses/en4620_2010/L03.pdf.

45/ *NPRM* at ¶ 46.

46/ *Id.* at ¶ 45 (citing to correspondence from the Fixed Wireless Communications Coalition).

47/ *Id*.

48/ *Id.* at ¶ 46.

f. Summary

As explained above, the interference potential from LPI transmissions is significantly below the more stringent[49/] -6 dB I/N interference criteria that is accepted by incumbents as the threshold for harmful interference.[50/] The Commission's goals of protecting incumbent licensed services while creating new opportunities for unlicensed devices to access spectrum can therefore be achieved without unnecessarily constraining LPI deployments in the U-NII-5 and U-NII-7 bands.

2. Protection of Mobile and Indoor Operations

The Commission also need not impose any additional restrictions on LPI devices in order to prevent interference to mobile or indoor licensed operations in the 6 GHz band.[51/] Unlike licensed fixed use of the 6 GHz band, licensed outdoor mobile operations in the 6 GHz band are intermittent and thereby entail significantly lower interference potential. Moreover, licensed outdoor mobile use of the 6 GHz band also will be protected from LPI operations due to the signal energy attenuation factors, outlined above. Similarly, no additional restrictions are necessary to protect licensed *indoor* operations. Where licensed operations occur indoors, they are almost exclusively under the control of a single entity, which either also controls or works closely with the facility in which the operations are taking place. Any operator of a facility that contains both licensed and unlicensed operations will be able to coordinate the radiofrequency environment by either shielding licensed devices or managing unlicensed frequencies (*e.g.*, AP

49/ The Commission specified possible interference protection criteria at I/N of 0 dB. *See id.* at ¶ 43.

50/ *See* Letter from Cheng-yi Liu, Counsel for the Fixed Wireless Communications Coalition to Marlene H. Dortch, Secretary, FCC, GN Docket No. 17-183, July 17, 2018 ("*FWCC Letter*") at Attachment at 14.

51/ *NPRM* at ¶ 61.

settings) to avoid interference.[52/] Therefore, additional constraints on low-power indoor U-NII operations are unnecessary.

3. Harmonization of Regulatory Requirements for LPI Devices Across the 6 GHz Band

The Commission's rules should be consistent for LPI devices that operate across the entire 6 GHz band. A single set of requirements that applies across the entire 6 GHz band will help support the deployment of devices using wider bandwidths (up to 160 megahertz) that, as discussed above, will characterize future Wi-Fi technology. In contrast, imposing an AFC obligation on LPI use in the U-NII-5 and U-NII-7 bands will fragment the 6 GHz band into non-contiguous segments, frustrating deployments and negating many of the benefits discussed above.

While standard-power operations with AFC will eventually play a major role in the 6 GHz band, industry will need time to develop and implement AFC capabilities. Mandating AFC for LPI in the U-NII-5 and U-NII-7 bands will inhibit availability of wider-bandwidth channels and impede the deployment of any unlicensed devices in that 850 megahertz of valuable spectrum, possibly for years, until AFC system(s) are commercially available. Allowing LPI access to the *entire* 6 GHz band without AFC would allow the unlicensed ecosystem to flourish without unnecessary regulatory delays and complexities. In contrast, restricting LPI access only to the 100 MHz in the U-NII-6 band and the 250 MHz in the U-NII-8 band would stifle innovation and the introduction of new types of devices, applications, and services to meet the public's evolving needs. That outcome is contrary to the public interest, which requires

---

[52/] "The Commission generally does not attempt to protect individuals from causing interference" to their own operations because of the high cost and performance limitations that would be required. *In the Matter of Revision of Part 15 of the Commission's Rules Regarding Ultra-Wideband Transmission Systems*, 18 FCC Rcd 3857 ¶ 119 n. 290 (2003).

immediate access to more contiguous spectrum capacity for Wi-Fi and other unlicensed technologies.

Moreover, allowing use of the entire 6 GHz band for LPI without AFC will facilitate regulatory alignment with other countries, promoting international frequency harmonization and equipment commonality, a major priority for the Commission.[53/] A fragmented regulatory approach to the 6 GHz U-NII sub-bands may prompt other administrations to take similar approaches for unlicensed operations, potentially requiring U.S. manufacturers to conform to a patchwork of national regulations.

4. LPI Client Devices

Wi-Fi Alliance agrees with the Commission that LPI client devices should be under the AP's control.[54/] This will further ensure protection of incumbent operations. While the Commission proposes to limit client device power to 63 mW, it should instead permit client devices to operate at the same power levels as the controlling LPI AP itself.[55/] Today, many LPI client devices are stationary (*e.g.*, television sets, appliances, etc.) and there is no reason to subject them to a different, more restrictive power limit because their operational environment and corresponding interference potential is the same as the associated AP.

Mobile LPI client devices are likely to be battery-powered and handheld and therefore will operate below the regulatory maximum power limit. Moreover, the signal energy of the mobile (handheld) LPI client devices would be reduced by body loss, further minimizing their

---

53/ For example, as noted by the Commission in the *NOI*, the European Conference of Postal and Telecommunications Administrations initiated an effort to introduce Wireless Access Systems, including RLAN in the 5925-6425 MHz band. *See NOI* at ¶ 4, n. 3.

54/ *NPRM* at ¶ 20.

55/ *See* proposed 47 C.F.R. §§ 15.407(a)(5) and (6).

interference potential.[56/] Allowing LPI client devices to operate at the controlling AP's power levels will not cause interference to incumbent services but will foster innovation in device and network design and in the overall IoT ecosystem.

5. Other Considerations for LPI Devices

The Commission's current 5 GHz U-NII rules do not require any additional measures to ensure indoor operations where that restriction is in place.[57/] LPI devices will be designed for indoor-use only; for example, they will not be designed to be weather-proof. They may also lack remote management features designed to facilitate management of an outdoor network. This means that these devices will not be appropriate for outdoor deployments, will not be marketed as such, and are unlikely to be used in this manner by consumers. Moreover, the gap between the cost of outdoor and indoor devices is narrowing. That means that there will be little reason for users to substitute indoor devices for outdoor use, particularly when those indoor devices may not perform as intended outdoors.

If it deems it necessary, the Commission can take further steps to ensure that LPI devices are not used outdoors. For example, it could prohibit the use of directional antennas on LPIs. Outdoor deployments typically rely on directional antennas to cover specific areas, such as restaurant patios, parking lots, and common areas. By prohibiting those antennas on LPI devices, the Commission could make it ineffective to use LPI devices for those purposes. The Commission could also issue device-certification guidelines that would require that LPI APs operate only when connected to a main power supply, preventing use in a battery-powered mode

---

56/ ITU Report M.2292 (showing an average body-loss of 4 dB for the 5 GHz range).

57/ *See* 47 C.F.R. §15.407(a)(1)(ii) (which exempts indoor APs from the elevation angle restriction applied to outdoor APs, but does not require any verification of indoor operation to quality for this exemption).

that would facilitate unauthorized outdoor operations. Such guidance should continue to permit legitimate use of other power supplies, such as DC powered-over-Ethernet by *bona fide* indoor devices, common for indoor enterprise deployments. There is no need for the Commission to specifically require connection to an AC wall outlet.

The Commission also could prohibit inappropriate marketing of LPI devices as suitable for outdoor use, or require some form of "indoor use only" labeling – in either physical or electronic label form – to ensure that consumers are aware of this restriction and that they may be subject to penalties for inappropriate outdoor use of a device certified only for indoor use.

There is no need, however, for the Commission to impose a professional installation requirement for LPI devices to ensure that devices operate only indoors. LPI devices will support, among other things, numerous consumer applications. It is impractical and unnecessary to require that consumers hire a professional installer to configure devices like gaming consoles or televisions.

B. Standard-Power Operations in the U-NII-5, U-NII-7, and U-NII-8 Bands

Wi-Fi Alliance strongly supports the Commission's proposal to make the U-NII-5 and U-NII-7 bands available for unlicensed operations at standard-power, subject to AFC use.[58/] The AFC system approach, as proposed by the Commission, will ensure protection for FS incumbents in these bands,[59/] while allowing this valuable spectrum to be used by unlicensed devices to extend broadband coverage beyond LPI operations. As explained below, the Commission also should allow standard-power operations with AFC in the U-NII-8 band.

58/ *NPRM* at ¶ 74.

59/ Based on the limited number of mobile assignments in these bands, AFC will be able to properly protect incumbent operations from interference from U-NII devices.

1. Determining Permissible Frequencies for Standard-Power Devices Using AFC

Wi-Fi Alliance agrees with the Commission that the AFC requirements should result in a simple database solution that is easy to implement.[60/] It would be counterproductive for the Commission to impose unnecessarily prescriptive parameters on AFC implementation. Instead, Commission regulations should focus on a technology-neutral, performance-based approach that will foster innovation while providing the necessary interference avoidance function.

a. General AFC Parameters

The AFC's function should be to identify permissible frequencies for standard-power AP operations at a given geographic location. An AFC's implementation of this function should be permitted to vary depending on technology and use cases, while still protecting incumbent operations. So, for instance, the Commission should not mandate where frequency-permission calculations should take place (at the device, in the cloud, etc.). This will enable device vendors or manufacturers to implement the AFC that is most appropriate for a particular use case, while still ensuring that permitted-frequency calculations are performed using Commission-specified criteria. The Commission should preserve flexibility to foster a vibrant AFC ecosystem and enable continued innovation that will lead to increased competition and lower costs for consumers.

Wi-Fi Alliance agrees with the Commission that its AFC requirements should be premised on determining frequency availability based on the actual fixed service receiver location, pointing direction, antenna pattern, and the effective isotropic radiated power ("EIRP") of the unlicensed device transmitter, along with its antenna location and direction, and the overall

60/ *NPRM* at ¶ 25.

propagation environment.[61/] In determining frequency availability, the AFC should be permitted to account for the AP's transmit power level, which may be lower than the maximum-allowed power level, thereby reducing the areas where the use of some frequencies may be restricted. Requiring the AFC to determine permissible frequencies only at the *maximum* allowed power level would be unnecessarily restrictive and reduce spectrum access. Nor should the AFC be required to "control" device power. Rather, the AFC should provide the device with a list of permissible frequencies at various transmit power levels and allow the device to select appropriate options based on its particular use case and operating parameters.

b. Use of Universal Licensing System ("ULS") Data

AFCs should rely on current ULS data, and AFCs should be required to only protect systems included in the ULS database – *i.e.* there should be no mandatory requirement to use third-party databases. As the Commission notes, ULS contains extensive technical data for site-based licenses, including transmitter and receiver locations, frequencies, bandwidths, polarizations, transmitter EIRP, antenna height, and the make and model of the antenna and equipment used.[62/] In fact, ULS contains all the necessary data fields for 6 GHz licensed incumbents for an AFC to determine where frequencies may be available for unlicensed use.

Wi-Fi Alliance agrees with the Commission that, although ULS data is not independently verified, mandatory information collection is not required to increase the efficacy of the AFC system, because licensees have significant incentives to maintain the continued accuracy of data in ULS to ensure that they are protected from harmful interference.[63/] Nevertheless, in order to facilitate the AFCs' effectiveness – and accurately account for all active incumbent operations –

61/ *Id.* at ¶ 37.

62/ *Id.* at ¶ 38.

63/ *Id.* at ¶ 39.

the Commission should issue a Public Notice offering licensees an opportunity to either affirm current operations or modify ULS entries to reflect existing use. This is similar to the Commission's recent action encouraging C-band FSS earth stations to register or update existing registrations in order to improve its understanding of those uses.[64/] ULS should be updated based on the responses received. To encourage responses, the Commission should consider an exceptional waiver on the submission of filing fees for ULS corrections as, for example, proposed by FWCC.[65/] If a licensee fails to affirm current operations, a notation should be added in ULS indicating that the operation of the non-responsive licensee need not be taken into account by unlicensed services. At any time, licensees should be allowed to remove this non-responsive notation by simply affirming existing ULS entries or updating their ULS records to reflect current use.

AFCs can also take into account temporary or conditional stations, if they are included in ULS. These facilities can and should be registered in ULS if the licensee wishes for those operations to be taken into account in coordination of U-NII frequency access. The Commission's rules may permit use of stations at multiple temporary locations without specifying particular transmitter sites; but licensees can elect to take advantage of the additional protection offered by an AFC by registering individual locations. Operations conducted under

---

64/ The Commission waived certain filing requirements and provided fee relief for operators with multiple stations. *See Temporary Freeze on Applications for New or Modified Fixed Satellite Service Earth Stations and Fixed Microwave Stations in the 3.7-4.2 GHz Band; 90-Day Window to File Applications for Earth Stations Currently Operating in 3.7-4.2 GHz Band*, GN Docket Nos. 17-183, 18-122, Public Notice, DA 18-398 (rel. Apr. 19, 2018); and *International Bureau Announces 90-Day Extension of Filing Window, to October 17, 2018, to File Applications for Earth Stations Currently Operating in the 3.7-4.2 GHz Band*; and *Filing Options for Operators with Multiple Earth Station Antennas*; GN Docket Nos. 17-183, 18-122, Public Notice, DA 18-639 (rel. June 21, 2018).

65/ *See* Letter from Cheng-yi Liu, Counsel for the Fixed Wireless Communications Coalition to Marlene H. Dortch, Secretary, FCC, GN Docket No. 17-183, ET Docket No. 18-295 (Oct. 15, 2018).

conditional authorizations can only occur after an application is submitted in ULS.[66/] Therefore, those stations will be protected because the relevant transmitter information will be reflected in ULS, allowing them to be reflected in AFC calculations.

c. Permissible Frequencies List Updates

As the Commission notes, the licensed deployment of the 6 GHz bands is not static.[67/] Data used in AFCs should therefore be updated as frequently as ULS is updated, so systems remain current with ULS data. But that does not mean devices should be required to constantly re-check with an AFC system before they operate. Licensed microwave links – even on a temporary basis – take months to construct and deploy. It therefore should be sufficient for the standard-power AP to verify available channel assignments with the AFC every 30 days. If an AP is unable to check with an AFC at the end of the 30-day period, a 48-hour grace period should be permitted; if the re-check cannot be performed by the end of the grace period, then the standard-power AP should be precluded from operating on U-NII-5, U-NII-7, or U-NII-8 frequencies.

Because a 30-day period is sufficient to update new licensed deployments, it is unnecessary to require an AFC system to direct standard-power APs to change frequencies between re-checks. An AFC system will provide AP devices with a revised permissible frequency list at every re-check, based on the most up-to-date information in ULS, which means that every new ULS entry will be taken into account within 30 days or fewer of registration.

66/ 47 C.F.R. § 101.31.

67/ *NPRM* at ¶ 29.

d. Protection Criteria for Use in AFC

An I/N ratio is the appropriate metric for the AFC interference protection criteria. Although the C/I metric offers a more precise interference criteria computation (*i.e.*, a more precise determination of available frequencies), it entails additional implementation complexities. As described in the *NPRM*, the I/N of 0 dB offers sufficient harmful interference protection to a licensed receiver.[68/] But, to further reduce the interference potential, Wi-Fi Alliance proposes that an AFC permissible frequency list and corresponding exclusion areas should be determined using a more conservative I/N ≤ -6 dB criteria. In fact, the Commission has already established this as the appropriate criteria for the protection of fixed service links in the 6 GHz band in a recent proceeding.[69/] This criteria results in less than a 1 dB fade margin reduction. These permitted-frequency calculations would be performed for each device separately, and there is no need for AFCs to track aggregate interference, because there is no meaningful risk of increased aggregate interference from U-NII devices. The Commission should verify each potential AFC's ability to correctly apply the I/N criteria as part of its certification process to ensure that an AFC accurately accounts for incumbent operations, but should not mandate a particular manner of calculation.

While certain baseline permitted-frequency results should be required, AFCs should be permitted to use more advanced parameters to achieve those results. For example, AFCs should be allowed to take clutter loss and terrain into account in performing their calculations. Potential AFCs would be required to demonstrate, as part of the certification process, that they will meet the protection criteria for incumbent systems even when they employ those additional metrics,

---

68/ *Id.* at ¶ 43.

69/ *In the Matter of Higher Ground LLC Application for Blanked Earth Station License*, 32 FCC Rcd 728 at ¶¶ 6, 25 (2017).

but the Commission should not be overly prescriptive with respect to the computation parameters or methods by which they will satisfy the I/N protection criteria.

e. Propagation Model

Wi-Fi Alliance agrees with the Commission that a free space path loss model would effectively assume worst case conditions and overestimate the potential interference.[70/] A combination of a short-range propagation model based on WINNER II and a beyond-line-of-sight model derived from the Irregular Terrain Model and ITU-R P.2108 models is best suited for the purpose of AFC permitted-frequency computation. In particular, the WINNER II model covers most relevant propagation scenarios including a variety of indoor locations, indoor hot-spots, typical urban micro-cells, typical urban macro-cells, sub-urban macro-cells, rural macro-cells, and line-of-sight urban macro-cells.[71/]

f. Calculation of Standard-Power Access Point Locations

In determining permitted-frequency lists, the Commission should allow AFCs to incorporate a predetermined level of uncertainty (in meters) at a 95% confidence level in determining the location of standard-power APs. The standard-power APs would be required to report their level of uncertainty to an AFC along with their determined location, which would take that uncertainty distance into account in the computation and corresponding limitation of the permitted-frequency list. This location accuracy information would be a part of every AFC query (including re-checks). This would permit devices with precisely known locations (such as permanent deployments performed by professional installers) to take advantage of the greatest

70/ *NPRM* at ¶ 49.

71/ *See* IST-4-027756 WINNER II D1.1.2 V1.2, WINNER II Channel Models, https://www.cept.org/files/8339/winner2%20-%20final%20report.pdf.

number of channels while protecting incumbent operations from potential location calculation errors.

The AFC permitted-frequency computation must be based on the standard-power AP's latitude, longitude, and height. With the inclusion of this requirement, there is no reason to restrict the installation of standard-power APs to below a specific height above ground level ("AGL"). To enable this functionality, the AFC can rely either on: 1) the AP's ability to geo-locate in three dimensions – latitude, longitude, and height AGL, or; 2) the AP's ability to geo-locate in two dimensions – latitude and longitude. In the latter case, the AFC, utilizing ULS data, can compute the permitted-frequency list based on the worst case assumption of the AP's height (which generally will be the height AGL of the potentially affected licensed receiver).

Because AFCs will be required to establish a permitted-frequency list based on a three-dimensional contour of the incumbent operations (either through location determination or worst-case assumptions), there is no reason to require professional installation for AFC-equipped devices. Professional installation, however, may be used as a method to establish three-dimensional geolocation coordinates for standard-power APs.

g. AFC System Operators

Wi-Fi Alliance supports the Commission's preliminary determination that it will designate multiple entities to operate AFC systems.[72/] However, the Commission need not impose a requirement that devices be able to communicate with multiple AFCs. The Commission should allow innovation in the market, and there is no functional purpose served by requiring interoperability with multiple AFC systems to prevent harmful interference, as described below. Any standard-power AP must be required to receive a list of permissible

72/ *NPRM* at ¶ 33.

frequencies from (*i.e.*, communicate with) a designated AFC system, but it does not need to be able to communicate with any more than one AFC system. Adding such a requirement will increase cost and reduce innovation in product and system design.

Similarly, there is no functional purpose served by requiring an AP to receive frequency information provided to neighboring devices by either the AFC with which it communicates or by other AFCs. Unlicensed devices will address coexistence and frequency access issues among each other in the same way unlicensed devices co-exist today – by using listen-before-talk or similar techniques.[73/] APs can be designed to manage frequency selection based on the radio environment, but that functionality should not be mandated.

As noted above, there is also no need for inter-AFC coordination. Inter-AFC coordination is not needed because aggregate interference will not be an issue in the 6 GHz band. An AFC will establish a permitted-frequency list on a case-by-case basis, while APs will manage unlicensed frequency access. Inter-AFC coordination will add significant cost and complexity without substantive improvement in functionality. The core requirement – preventing interference from standard-power 6 GHz unlicensed operations – does not require inter-AFC coordination.

Finally, the Commission should not restrict AFC operator eligibility to specific entities or a class of entities. Any entity, including U-NII equipment vendors or manufacturers, should be allowed to provide AFC functionality. Diversity in AFC systems will promote a full range of innovations in product and service offerings. The Commission, therefore, should adopt

---

[73/] IEEE, PART 11: WIRELESS LAN MEDIUM ACCESS CONTROL AND PHYSICAL LAYER SPECIFICATIONS, IEEE 802.11 (2016), https://ieeexplore.ieee.org/servlet/opac?punumber=7786993.

regulations that would foster a market-driven, technology-neutral environment for the development of the AFC function.

h. Standard-Power Client Devices

Wi-Fi Alliance agrees with the Commission's proposal to require standard-power client devices to operate under the control of a standard-power AP.[74/] Client devices should be able to operate at the same power as the standard-power AP to support balanced network coverage. To manage potential interference from client devices, the AFC must include an additional buffer in its calculation of the permitted-frequency list to account for client devices that may be operating at the outer boundaries of the AP's own range (*i.e.*, a worst case assumption).[75/] Further interference mitigation from portable client devices will be provided by reduced transmit power levels due to the use of battery and other factors noted above.

The Commission questions whether protection from interference is required when a 6 GHz band client device initiates a frequency assignment, or "probe," request prior to coming under the control of an AP.[76/] Probe requests from client devices are milliseconds in duration and infrequent – they occur when a client is searching for a new network with which to associate, or shortly after association. Therefore, the probability of interference from such requests is negligible, and there is no need for the Commission to regulate a client device's probe requests.

i. AFC System Certification, Operator Requirements, and Fees

The AFC certification process should focus only on confirming that an applicant can fulfill the requirement to identify and communicate a list of permissible frequencies to a

---

74/ *NPRM* at ¶ 53.

75/ The AFC should be permitted to take into account the power level of the client devices that may be operating on its network (for example, stationary, higher-powered stationary devices vs. lower-powered handheld devices), adjusting protection contours as needed.

76/ *NPRM* at ¶ 53.

standard-power AP at a specified geographic location. The AFC certification should assess an applicant system's ability to perform the computation, but it should not mandate the manner of the calculations. As explained above, AFC implementation may vary depending on technology, use cases, vendors, and other factors, and the Commission should ensure that its certification processes foster this innovation, incorporating flexible procedures for making certification decisions.

Because of the benefits of promoting diverse AFC system implementations, Wi-Fi Alliance does not support the designation of a multi-stakeholder entity to administer AFC system requirements. Groups like Wi-Fi Alliance will play an active role in promoting the Wi-Fi ecosystem in the 6 GHz U-NII bands, but there is no need for regulatory oversight of this role beyond the certification of the AFC's functionality.

Wi-Fi Alliance supports the Commission's proposal to designate an AFC system operator for a five-year term that can be renewed at the operator's request by the Commission, based on the operator's performance during the term.[77/] However, it is impractical to require the AFC operator to transfer registration data at the end of its term. Designation of an entity as an AFC operator should *permit* AFC operations, but not *obligate* the entity to perform those functions. An AFC operator should have the flexibility to discontinue provision of the AFC function at its discretion. In the event an AFC system ceases operations, all AP devices that employed that AFC would be automatically adjusted within 30 days by the mandatory AFC re-check requirement, as described above. At that time, standard-power APs would be required to either migrate to a new AFC system, cease operation in the 6 GHz band, or switch to LPI operations (if

77/ *See* proposed 47 C.F.R. § 15.407(k).

permitted, based on operational characteristics) when no recheck can be performed with the defunct AFC.

Finally, AFCs should be permitted to charge market-based fees, as White Space administrators and 3.5 GHz Spectrum Access Systems are permitted to today.[78/] As in each of those bands, fee structures for AFCs should be determined between AFC operators and users based on market conditions, not on Commission-imposed structures. The existence of adjacent U-NII bands in the 5 GHz band, which are not subject to these fees, and the availability of LPI devices without AFC throughout the 6 GHz band, will act as a check on AFC fees.

j. Standard-Power AP Registration and Security Requirements

Device registration and/or transmitter identification serves no purpose in protecting incumbents from interference and therefore need not be captured in the AFC database. The interference avoidance role of the AFC is outbound only – to provide to APs information about where, and on which frequencies, they can operate. The AFC need not collect identification information from APs to perform this function. A requirement for either or both would add cost and complexity and impose potential security risks without enhancing the interference AFC management function.

Even without device registration and/or transmitter identification requirements, the Commission should consider imposing non-burdensome security obligations on AFC operators. Sections 15.713 and 96.61 of the rules contain non-prescriptive security requirements for White Space device databases and 3.5 GHz Spectrum Access Systems, respectively.[79/] Similar requirements should be adopted for AFC operators. With regards to device security, the current

78/ *See* 47 C.F.R. §§ 15.714 (on white space database administrator fees) and 96.65 (Spectrum Access System administrator fees).

79/ *See* 47 C.F.R. §§ 15.713 and 96.61.

version of Section 15.407 of the rules provides that devices must include security to prevent software modification by unauthorized parties in order to ensure that devices remain in compliance once they are in customers' hands; but the Commission does not mandate the form of that security, allowing manufacturers to innovate.[80/] This approach has been successful and the Commission should adopt it for the 6 GHz band.

k. Wireless Microphones and Other Part 74 Devices

Part 74 of the rules permits the use of wireless microphones and other low power auxiliary devices in the 6875-6900 MHz and 7100-7125 MHz bands. These devices operate at low power in defined locations on a licensed basis, but are secondary to BAS, Cable Television Relay Service ("CARS"), and FS licenses. Their operations are limited to the production of "broadcast programs, motion pictures, and major events or productions,"[81/] and licenses are limited to radio, TV, and BAS licensees, broadcast networks, cable operators, TV and movie producers, large venue owners, and professional sound companies.[82/] This means that Part 74 operations are confined to a limited number of locations and are controlled by an even more limited number of entities that generally have, or work closely with, someone who has control over the location of operations, reducing the risk of interference from U-NII devices.[83/] Part 74 licenses are included in the ULS database, so they can be protected by an AFC. A search of the ULS database for Broadcast Auxiliary Low Power authorizations revealed only a few licenses in the 6 GHz band.[84/]

80/ 47 C.F.R. § 15.407(i).

81/ *Id.* § 74.831.

82/ *Id.* § 74.832(a).

83/ As noted above, the Commission generally does not intervene to prevent interference between different devices under the same user's control. *See supra*, note 52.

84/ *See generally* FCC Universal Licensing System.

Moreover, because of the nature of wireless microphone and other low-power auxiliary operations, they are similar to indoor FS operations (which also operate in confined spaces generally under the control of a single entity capable of controlling for interference) and are unlikely to suffer any harmful interference from standard-power operations.

2. Standard-Power Point-To-Point Operations

The Commission's rules governing unlicensed devices in the 2.4 GHz and 5 GHz U-NII bands allow for different operating parameters for point-to-multipoint systems on the one hand and point-to-point systems on the other.[85/] In particular, in each case, the rules permit antenna gains greater than 6 dBi under certain circumstances.[86/] In order to promote the use of the 6 GHz band by point-to-point systems (in addition to Wi-Fi, which is generally configured for omnidirectional transmissions) the Commission should extend the point-to-point rules that apply today to the 2.4 GHz and 5 GHz bands to the 6 GHz band. This will facilitate use of the band by wireless Internet service providers, which will be particularly useful for providing broadband connectivity to underserved areas.

Wi-Fi Alliance agrees with the Wireless Internet Service Providers Association ("WISPA") that "[g]iven increasing congestion in the nearby 5 GHz band, WISPA believes that, if the rules permit, existing 5 GHz U-NII equipment can be easily certified for operation in the U-NII-5 and U-NII-7 bands and fixed wireless broadband providers would quickly deploy service to relieve congestion and provide higher quality service to consumers."[87/] Moreover,

---

85/ *See, e.g.*, 47 C.F.R. § 15.247(c)(1).

86/ *Id.*

87/ *See* Letter from Stephen E. Coran, Counsel, Wireless Internet Service Providers Association, to Marlene H. Dortch, Secretary, FCC, GN Docket No. 17-183, ET Docket No. 18-295 (Oct. 17, 2018).

operations in the U-NII-8 band using AFC technology in more rural areas, where TV pickup operations are not licensed, would help advance the Commission's broadband connectivity goals.

3. Standard-Power AFC Operations in the U-NII-8 Band

While the Commission has proposed that standard-power operations be permitted in the U-NII-5 and U-NII-7 bands,[88/] use of an AFC also will allow standard-power APs in the U-NII-8 band. In 2011, after careful review, the Commission decided to permit fixed station operations in the 6875-7125 MHz band in areas where TV pickup operations are not licensed.[89/] In reaching this decision, the Commission determined that there are no BAS and CARS operations in 54% of the land area of the United States and that those operations are "largely located in more rural, especially in the midwestern and western regions."[90/] Further, mobile (as opposed to fixed) BAS and CARS assignments comprise only 2% of overall U-NII-8 licenses.[91/]

Recognizing the important role that U-NII devices can play in closing the digital divide by providing ubiquitous connectivity in underserved areas, Wi-Fi Alliance urges the Commission to adopt rules for the U-NII-8 band that are similar to those that will govern the U-NII-5 and U-NII-7 bands. Specifically, similar to the U-NII-5 and U-NII-7 bands, standard-power APs should be permitted to operate on U-NII-8 frequencies outside of areas where BAS and CARS use is licensed.[92/]

88/ *See* proposed 47 C.F.R. §15.407(k)(1).

89/ *In the Matter of Amendment of Part 101 of the Commission's Rules to Facilitate the Use of Microwave for Wireless Backhaul and Other Uses and to Provide Additional Flexibility to Broadcast Auxiliary Service and Operational Fixed Microwave Licensees,* Report and Order, 26 FCC Rcd 11614 at ¶ 10 (2011).

90/ *Id*. at ¶ 22.

91/ *NPRM* at ¶ 74.

92/ Wi-Fi Alliance recognizes that data regarding CARS stations are not contained in ULS, but rather in the Cable Operations and Licensing System ("COALS"). That will either require AFCs to access that database or for the Commission to expand ULS to incorporate the CARS data.

C. Mobile and Transportable Operations

The proposed rules cover the majority of the anticipated U-NII use cases in the 6 GHz band – by LPI and standard-power APs and their associated client devices. Nevertheless, as technology evolves, mobile and transportable APs will constitute important use cases in the Wi-Fi ecosystem, addressing the growing demand for mobile connectivity. In light of that, Wi-Fi Alliance urges the Commission to consider rules for the 6 GHz band that accommodate those devices.[93/]

The Commission's goal of fostering innovation in and use of the 6 GHz band while protecting incumbent operations can be achieved by permitting mobile and transportable U-NII operations in the 6 GHz at an appropriate power level. The Commission's proposal for LPI devices establishes a baseline for regulating mobile and transportable U-NII operations in the 6 GHz band. Specifically, mobile and transportable U-NII operations in the 6 GHz band should be allowed to operate as long as their interference potential (*i.e.*, signal energy at the 6 GHz licensed receivers) is no greater than the interference potential of LPI transmissions, or their operations are managed by an AFC system.

In considering LPI transmissions, the Commission accurately observed that BEL is especially relevant in ensuring compatibility between LPI APs and licensed users.[94/] Similarly, the Commission should take into account signal attenuation provided by a vehicle or a user's body based on the particular characteristics of the mobile and transportable operations (for example, aboard trains, or automobiles, handheld hotspots, etc.). In other words, consistent with

---

93/ *NPRM* at ¶ 76. The Commission proposes to prohibit 6 GHz operations in moving vehicles, but it should instead permit them subject to the rules discussed here. *Id.* at ¶ 84 and proposed 47 C.F.R. § 15.407(d)(1).

94/ *NPRM* at ¶ 70.

the regulatory approach to LPI devices, the Commission should establish appropriate transmission power levels for mobile and transportable operations factoring in vehicle and body losses instead of BEL. The values of these losses have been extensively analysed and are summarized below:

- Ground based vehicles, such as automobiles and trains, provide signal attenuation in the 8 dB to 12 dB range.[95/]
- Passenger aircraft fuselage operating above 10,000 feet provides signal attenuation of approximately 18 dB.[96/]
- Signals from handheld devices operating as APs are attenuated by the user's body in the same manner as client devices, discussed above. A report by the ITU indicates that the appropriate attenuation value for bands between 3 GHz and 6 GHz is 4 dB.[97/]

In establishing appropriate transmit power levels for mobile and transportable U-NII devices, the Commission also should take into account that these devices will have minimal probability of operating in the main beam of licensed receivers at an average height of 40 meters AGL.

95/ *See* EUROPEAN TELECOMMUNICATIONS STANDARDS INSTITUTE ETSI TR 103 086 (2013), https://www.etsi.org/deliver/etsi_tr/103000_103099/103086/01.01.01_60/tr_103086v010101p.pdf; and EC JOINT RESEARCH CENTER, CEPT REPORT 17 Annex 2, Table 4, (2007) https://www.ecodocdb.dk/download/a99331df-48dc/CEPTREP017.PDF.

96/ *See* IEEE, Dynamic Frequency Selection Functionality with Airborne Radio Local Area Networks Flight Tests, Results, and Conclusions, D6-83753, https://mentor.ieee.org/802.18/dcn/09/18-09-0013-00-0000-boeing-ec-airborne-dfs-report.pdf at Sec. 3.3.3.1.

97/ *See* ITU Report M.2292 (Dec. 2013).

D. Satellite Service Protection

The Commission correctly concludes that use of an AFC is not necessary to protect satellite receivers because the limits on radiated power will prevent interference to space station receivers from individual unlicensed devices.[98/] There is also no need to mandate restrictions on pointing toward the geostationary arc. 6 GHz satellite receivers operate in geostationary orbits ("GSOs") approximately 36,000 kilometers above the equator, while the Sirius/XM satellite receivers (in the 7025-7075 MHz band) operate in a highly elliptical orbit, even further away when orbiting over the continental United States. The significant separation distances between ground-based U-NII transmitters and space-based satellite receivers provide ample isolation to mitigate against the potential of aggregate harmful interference. This conclusion is demonstrated by the technical analyses provided in the Annex to these comments.

While Wi-Fi Alliance initially indicated support for an antenna pointing restriction, limiting the power transmitted above an elevation angle of 30 degrees,[99/] based on further analysis, it appears that such restrictions are unnecessary. As it noted in a subsequent *ex parte* letter, the initial proposal was based on the industry's experience in the U-NII-1 band, where mechanisms were necessary to protect those FSS operations.[100/] However, because of the different nature of the FSS operations in the U-NII-1 and 6 GHz bands, such protections are not required here.

Similarly, the Commission need not impose any requirement on private parties to monitor aggregate interference to satellite receivers, nor does the Commission need to engage in such

---

98/ *NPRM* at ¶ 55.

99/ *Id.* at ¶ 55.

100/ Letter from Alex Roytblat, Senior Director, Regulatory Affairs, Wi-Fi Alliance, to Marlene H. Dortch, Secretary, FCC, GN Docket No. 17-183 (filed Aug. 8, 2018).

monitoring itself. Based on experience with U-NII operations in the 5 GHz band, deployment of U-NII devices outdoors will be limited (< 2%)[101/] and will take several years to reach full deployment level.

With regard to possible future deployments of space-to-Earth links,[102/] there is no reason to expect interference from U-NII operations. As noted in the *NPRM*, no earth stations are currently licensed to use this allocation in the space-to-Earth direction. But hypothetically, future deployments are likely to mirror current ones in other frequency bands, meaning there will be few gateway earth stations and most will be situated in isolated and secured areas, reducing the likelihood of interference from U-NII devices. In the highly unlikely event of interference to an earth station receiver caused by a U-NII device, there are several mitigation methods, such as site shielding, available to that station.

E. Technical Rules

Wi-Fi Alliance supports the Commission's proposed technical rules, with minor modifications suggested below.

1. Power Limits

The Commission correctly considers whether it should impose particular power spectral density ("PSD") restrictions, as it currently does in its existing U-NII band rules.[103/] These limits are out-of-date based on advances in next-generation Wi-Fi (802.11ax) technology that allow devices to narrow their channels and focus their power as needed, without increasing overall

---

101/ *See* Contribution of the United State of America to the International Telecommunications Union, Radiocommunication Study Groups, Working Document toward a preliminary draft new Report ITU-R M.[RLAN REQ-PAR], Technical characteristics and operational requirements of WAS/RLAN in the 5 GHz frequency range Document 5A/893-E (Oct. 23, 2018).

102/ *NPRM* at ¶ 58.

103/ *Id.* at ¶ 80.

power levels or interference risk. One way that devices achieve this result is by aligning their 2 megahertz PSD with the total power limit. In contrast, the 5 GHz U-NII band rules assume a consistent 20 megahertz channel and do not allow devices to select a narrower channel for PSD purposes.

While the Commission proposes to limit client power to 63 milliwatts,[104/] as noted above, it should instead align client device power limits with AP power levels, as it does in the U-NII-3 band.[105/] This will allow for maximum flexibility in system design. As discussed above, for standard-power networks, the AFC can account for the permitted power level of client devices in its interference calculation, expanding its protection contour and limiting its permitted frequencies as needed to ensure full protection. In LPI operations, fixed client devices operate under the same conditions as APs, and therefore present no risk beyond those of APs (which, as noted above, is negligible). Portable client devices typically have one or two antennas, which limit their transmit power (and therefore interference risk).

2. Unwanted Emissions Limits

Wi-Fi Alliance supports the Commission's proposal to impose out-of-band emissions ("OOBE") limits only on the edges of the band;[106/] there is no need to specify OOBE limits between the 6 GHz U-NII sub-bands. Unlike the 5 GHz band, there is no diversity in protection needs for incumbent services in the 6 GHz sub-bands that requires such limits. The Commission need only establish limits at the lower edge of the U-NII-5 band and the upper edge of the U-NII-8 band to ensure full incumbent protection. Similarly, there is no need to regulate U-NII devices' transmit emission mask in order to protect incumbent services operating on adjacent

---

104/ *Id.* at ¶ 78.

105/ 47 C.F.R. § 407(a)(3).

106/ *NPRM* at ¶ 82.

frequencies within the 6 GHz band. Significantly lower power transmissions by U-NII devices will produce negligible out-of-band power levels that need not be regulated. As demonstrated in the report prepared by RKF Engineering, the worst case analysis of the OOBE resulted in a 0.01 dB increase to the in-band noise.[107/]

3. Coexistence with Ultra-Wideband Devices

Wi-Fi Alliance concurs with the Commission that there is no need for additional rules to ensure coexistence between ultra-wideband ("UWB") and U-NII operations in the 6 GHz band.[108/] Throughout the history of unlicensed devices, the Commission has made clear that all devices authorized under Part 15, including UWB devices, operate on a "sufferance" basis.[109/] Further, as noted above, given the short range of both U-NII and UWB devices, as well as the nature of UWB operations, much of the interference potential between the two unlicensed applications will be confined to particular locations under the control of a single entity; in these situations, the Commission correctly leaves it to that entity to manage interference, rather than imposing costly and burdensome protection requirements on devices generally.[110/]

107/ *See* RKF Engineering, *Frequency Sharing for Radio Local Area Networks in the 6 GHz Band*, at 53, attachment to Letter from Paul Margie, Counsel to Apple, Inc., Broadcom Corporation, Facebook, Hewlett Packard Enterprise, and Microsoft Corporation, to Marlene H. Dortch, Secretary, FCC, GN Docket No. 17-183 (filed Jan. 25, 2018).

108/ *NPRM* at ¶ 72.

109/ *See In the Matter of Revision of Part 15 of the Commission's Rules Regarding Ultra WideBand Transmission Systems*, Report and Order, 17 FCC Rcd 7435 at n. 2 (2002) (noting that "one of the primary operating conditions under Part 15 are that the operator must accept whatever interference is received and must correct whatever interference is caused"); *Petition for Waiver of the Part 15 UWB Regulations Filed by the Multi-band OFDM Alliance Special Interest Group*, Order, 20 FCC Rcd 5528 at ¶ 2 (2005) (noting that "UWB devices are not allocated spectrum but share these frequency bands with the authorized radio services on a sufferance basis.").

110/ *Supra* note 52.

III. CONCLUSIONS

Over the last two decades, Wi-Fi technology has created a distributed network that delivers connectivity where it is needed most – in homes, offices, public venues, stadiums, and countless other places. Wi-Fi has done this while protecting other spectrum users, making efficient use of available unlicensed spectrum. Today, Wi-Fi is essential to the Nation's ability to connect, but its functionality is threatened by insufficient spectrum capacity. The next generation of Wi-Fi – Wi-Fi 6 – is designed to deliver greater capacity, faster speeds, and lower latency to support forthcoming connectivity needs such as 5G applications. Those capabilities require access to contiguous swaths of mid-band spectrum in the 6 GHz band. Wi-Fi Alliance, therefore, urges the Commission to complete this proceeding quickly and make needed unlicensed spectrum available to support Wi-Fi technology performance and evolution.

Respectfully submitted,

/s/ Alex Roytblat

Alex Roytblat
Senior Director of Regulatory Affairs

WI-FI ALLIANCE
10900-B Stonelake Blvd.
Suite 126
Austin, TX 78759
(512) 498-9434
aroytblat@wi-fi.org

February 15, 2019

ANNEX
WI-FI ALLIANCE COMMENTS
ET DOCKET NO. 18-295
GN DOCKET NO. 17-183

Analysis of U-NII interference to
Geostationary Fixed Satellite Service Receivers
In the 6 GHz band

1. INTRODUCTION

This document presents an analysis of interference from unlicensed radio local area networks (RLANs) in 5.925-7.150 GHz band in the continental US to the geostationary fixed satellite system uplink (i.e. satellite receivers).

2. ANALYSIS METHODOLOGY AND ASSUMPTIONS

The I/N at the satellite receiver is computed per equation below:

$$\frac{I}{N} = EIRP + 10log10(Bandwidth\ Correction) - L_{polarization} - L_{bldg} - L_{clutter} - FSPL + G/T - 10log10(k \times BW)$$

Where,

$\frac{I}{N}$: Interference to Noise Ratio (dB)
$EIRP$: RLANs average EIRP over 5,925 - 7,125 MHz (dBW)
$Bandwidth\ Correction$: Correction term to calculate RLAN EIRP that is over the satellite receiver noise bandwidth [=0.03 = 36/(7125-5925)]
$L_{polarization}$: Polarization loss [=3] (dB)
L_{bldg}: Building Penetration Loss (dB)
$L_{clutter}$: Clutter Loss (dB)
$FSPL$: Free Space Path Loss (dB) [assume 6,175 MHz and 35,805 km (shortest distance to SES-2 from CONUS]
$\frac{G}{T}$: Satellite receiver G/T (dB/K)
$k: Boltzmann's\ Constant$: 1.38064852 × 10^{-23} m^2 kg s^{-2} K^{-1}
BW: Satellite receiver noise bandwidth [=36*10^6] (Hz)

Total number of simultaneously transmitting RLANs (combined indoor and outdoor, and client vs. access point) is assumed 841,498. Table 1 below shows the underlying assumptions.

Table 1 – Determination of On-Tune Active RLAN Devices

POPULATION	346943000	2025 US population projection
UNLICENSED FACTOR	90%	Percentage of devices using unlicensed spectrum
BUSY HOUR FACTOR	62.7%	Percentage of population using wireless
6 GHz FACTOR	68.2%	Percentage of unlicensed devices using 6 GHz bands
MARKET FACTOR	32%	Percentage of devices with 6 GHz capability in 2025
DUTY CYCLE	1.97%	Average duty cycle
ACTIVE RLAN DEVICES	**841,498**	Number of actively transmitting devices

RLANs' average EIRP is computed using the EIRP distributions per Table 1 and Table 2 of ETSI TR 103 524[1/], and assuming 98% indoor and 2% outdoor. RLANs' frequency band is per Figure 1 of ETSI TR 103 524.

Average building penetration loss is used as 18 dB and 30 dB for traditional buildings and thermally efficient buildings respectively, per the *NPRM*,[2/] for indoor RLANs. The building penetration loss is 0 dB for outdoor RLANs (worst case assumption). The clutter loss is assumed 0 dB (worst-case assumption).

SES-2 at 87 West longitude has been chosen for this analysis as (a) it has coverage over all of CONUS within a beam contour that is 2 dB down from the peak gain, and (b) it has high peak G/T for a conservative estimation.

Figure 1 shows SES-2 receive G/T contour,[3/] denoting amount of dB down from the peak G/T. SES-2 Peak G/T is 3.39 dB/K. The noise bandwidth of this satellite is 36 MHz.

1/ ETSI TR 103 524 V1.1.1 (2018-10) "System Reference document (SRdoc); Wireless access systems including radio local area networks (WAS/RLANs) in the band 5925 MHz to 6725 MHz.

2/ *NPRM* at ¶ 70

3/ IBFS database file number: SAT-AMD-20110613-00107.

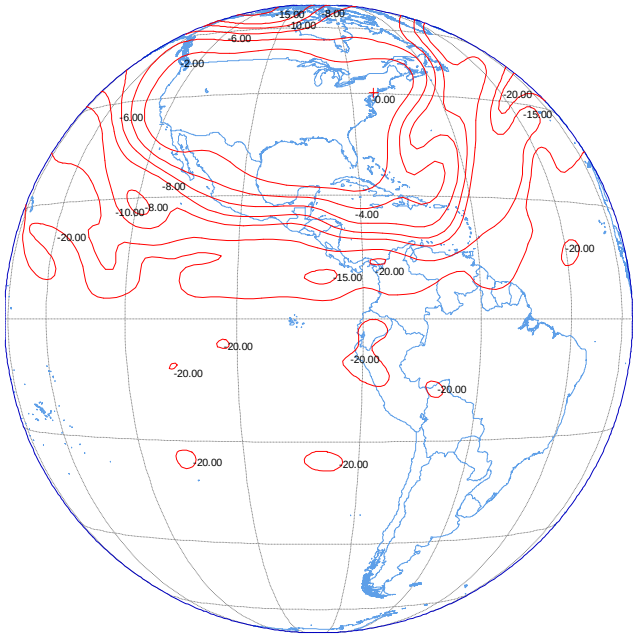


Figure 1 - SES-2 G/T Contour at 87W

3. ANALYSIS RESULTS

Using assumptions per the previous section, Table 2 shows a representative link budget calculating an average I/N from all RLANs over CONUS at the Satellite receiver using worst-case assumptions. The resulting I/N is -24.87 dB.

Table 2 - FSS Representative Link Budget

Parameter	Unit	Value	Reference
Satellite Longitude	Deg	-87	SES-2
Coverage Region		CONUS	
Number of Active RLANs		841,498	Per Table 2.1
Avg. EIRP per RLAN			
Indoor Traditional Building (70%)	mWatt	38.4	Per ETSI TR 103 524
Indoor Thermally Efficient Building (30%)	mWatt	16.5	Per ETSI TR 103 524
Outdoor (2%)	mWatt	1.5	Per ETSI TR 103 524
Total	mWatt	56.34	
Building Loss (Indoor RLAN)			
Traditional Building	dB	18	Per FCC NPRM, paragraph 70
Thermally Efficient Building	dB	30	Per FCC NPRM, paragraph 70

Aggregate Avg. EIRP (all RLANs) after building loss			
Indoor Traditional Building (70%)	dBW	27	
Indoor Thermally Efficient Building (30%)	dBW	11	
Outdoor (2%)	dBW	31	
Total	dBW	33	
Bandwidth Correction		0.03	= 36 / 1200
Aggregate Avg. EIRP (Bandwidth Correction)	dBW	17	
Free Space Path Loss	dB	199.58	Range to Satellite of 36,805 km (shortest distance from CONUS to SES-2)
Polarization Loss	dB	3	
Clutter Loss	dB	0	Worst-case
Aggregate Interference at Satellite	dBW	-185.28	
Satellite Receiver Antenna G/T	dB/K	3.39	Peak G/T for SES-2
Boltzmann's Constant	dBW/K/Hz	-228.60	
Satellite Noise Bandwidth	MHz	36.0	
Aggregate Avg. I/N	dB	-28.85	

4. CONCLUSION

An aggregate interference from RLANs over CONUS is calculated at 28.85 below the satellite receiver noise. The results indicate that deployment of RLANs over CONUS does not impact the FSS uplink.